New High-Temperature Coating for Gas Turbine Components

New coating improves cracking resistance and preserves oxidation protection for hot-section components of gas turbines

Benefits

- Saves energy through extending the life of coated components, such as first-stage buckets and other hot-section components of gas turbines
- Potential to save approximately $290,000 per year per turbine due to extended coating wear life
- Early results show the new coating has the potential to outperform two-layer MCrAlY aluminide coatings by 60 to 100 percent
- Preserves high-temperature oxidation protection of MCrAlY coatings
- Eliminates the regulated chemical waste generated by current processes

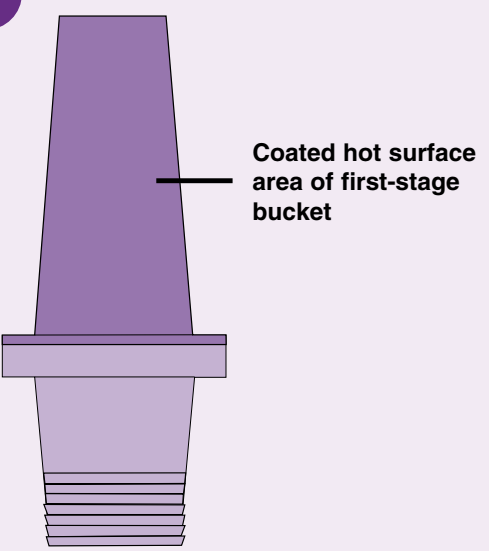
Applications

The new high-temperature coating for gas turbines is applicable to a wide range of gas turbines. Initial emphasis will be on industrial turbines with cracking problems on hot-section components. As Turbine Coatings, Inc., gains more experience with the new coating, however, additional applications will be explored in aerospace, transportation, and other appropriate industries, for use with both new and refurbished turbines.

Large gas turbines with high thermal efficiencies, such as those used by utilities, can contain components that experience extremely high temperatures, which can cause oxidation of the turbine's expensive superalloy components. For many years, MCrAlY coatings (where **M** represents iron, nickel, and cobalt; **Cr** represents chromium; **Al** represents aluminum; and **Y** represents yttrium) have been applied to these hot-section turbine components to protect against high-temperature oxidation. In addition, a separate aluminide layer may be deposited over the coating to enhance oxidation protection. While this combination of coatings helps to reduce oxidation, it can still result in brittleness and cracking that shortens the useful life of the components.

A new high-temperature coating for gas turbines is being developed as a replacement for the conventional MCrAlY and aluminized MCrAlY coatings. This new coating provides superior cracking resistance and oxidation protection to the hot-section components of gas turbines, while reducing manufacturing cycle time and cost. In addition, the process for applying the new coating will be more environmentally friendly than current techniques.

High-Temperature Coating for Gas Turbines



A new high-temperature coating extends the useful life of hot-section components in gas turbine engines, while reducing manufacturing time and cost.

Project Description

Goal: Develop a superior crack- and oxidation-resistant coating and the means for applying this coating to hot-section components of gas turbines in a manufacturing environment.

Turbine manufacturers have for years used MCrAlY coatings to protect the hot-section components of turbines against corrosion and oxidation. For applications experiencing extremely high firing temperatures, more aluminum is added to enhance the coating's protection. However, when the aluminum concentration exceeds 10 to 13 wt. percent, the MCrAlY coating tends to become brittle, often causing delamination of the coating from its substrate. Even when a protective aluminide layer is added over the MCrAlY coating, the aluminide layer itself is subject to brittleness and cracking.

Recent research by Turbine Coatings, Inc., of Schenectady, New York, has yielded promising results favoring the development of a new high-temperature coating with superior protection capabilities. The key to the new coating is a proprietary design in which the coating possesses ductility, while still preserving needed oxidation resistance. Equally important is the process by which the new coating will be applied to the equipment. These breakthroughs, when scaled up to a manufacturing level, are expected to lead to time and cost savings, as well as to extended life of the turbine's hot-section components.

Turbine Coatings, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Tests confirmed the enhanced cracking resistance and oxidation protection of the coating produced at the scaled-up level.
- Improve coating materials and application processes on a manufacturing-scale level.
- Demonstrate the improved coating process.
- Prepare for prototype testing of the coating on an in-service gas turbine.

Economics and Commercial Potential

The potential for cost, energy, and environmental savings associated with the new high-temperature coating for gas turbines is substantial. Currently, the application of today's aluminized coatings is a two-step process costing $3,500 per bucket, or $322,000 for one set of 92 first-stage buckets. In contrast, the new coating eliminates the aluminization step, effectively reducing costs by half. Further savings are expected from doubling the normal life of the first-stage buckets made of expensive, nickel-based superalloy. Overall, these savings are equivalent to 40 cents per MWh in operating efficiencies.

Eliminating the aluminization step also provides an environmental advantage. Each run of the aluminization process produces hundreds of pounds of waste powder containing one to two percent hexavalent chromium, a water-soluble substance regulated by the EPA. In comparison, the new coating will be applied without the aluminization process, using materials that are not EPA regulated.

Turbine Coatings, Inc., developer of the new high-temperature coating for gas turbines, estimates the existing U.S. market for the technology at $26.8 million, with sales of new targeted turbines adding $7.6 million more each year. The company intends to pursue a licensing-based commercialization strategy, whereby the benefits of the new coating will be marketed to turbine users, while the technology itself is licensed to coating companies.

Industrial Materials for the Future

The Industrial Materials for the Future Program focuses on the development and commercialization of new or improved materials that enhance productivity, product quality, and energy efficiency in the major process industries. These materials resist high-temperature fatigue, corrosion, and wear. Research focuses on metallic and intermetallic alloys, structural polymers and membrane materials, and materials processing methods.

The OIT Industrial Materials Leader: Charles A. Sorrell (202) 586-1514.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

Project Partners

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